Chromium

What Is It? Chromium is an element found naturally in rocks, soil, plants, and animals, including people. It occurs in combination with other elements as chromium salts, some of which are soluble in water. The pure metallic form rarely occurs naturally. Chromium does not evaporate, but it can be present in air as particles. Because it is an element, chromium does not degrade nor can it be destroyed.

Symbol:	**Cr**
Atomic Number: *(protons in nucleus)*	**24**
Atomic Weight:	**52**

How Is It Used? Chromium is used to make steel and other alloys, for chrome plating, and as an additive to limit corrosion. Named for its colored compounds, chromium has also been used to make dyes and pigments for paints, make bricks in furnaces, tan leather, and preserve wood.

What's in the Environment? Chromium is present everywhere. In nature, it is found in three forms: metal ore, trivalent chromium (Cr III), and hexavalent chromium (Cr VI). Trivalent chromium occurs naturally in many fresh vegetables, fruits, meat, grains, and yeast. Relatively insoluble, it is the most prevalent form in surface soils where oxidation processes (which convert chromium from the hexavalent to trivalent form) are most common. Hexavalent chromium also occurs naturally, notably in saturated (reducing) conditions, and it is an indicator of man-caused pollution. This form is relatively soluble and can move down through soil to underlying groundwater more readily.

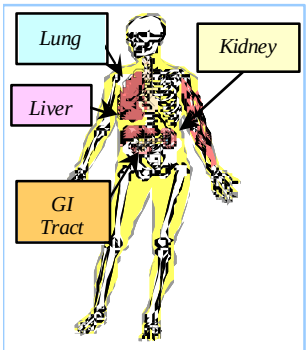
The concentration of naturally occurring chromium in U.S. soil ranges from 1 to 2,000 parts per million (ppm), and the average concentration is 54 ppm. The concentration of chromium in sandy soil particles is estimated to be 70 times higher than in interstitial water (the water in the pore spaces between the particles), and concentration ratios are higher (e.g., 1,500) for clay soil. The typical ratio of chromium in plants to chromium in soil is estimated at 0.0045 (or 0.45%).

Chromium concentrations in air and water are very low. In air, it generally ranges between 0.01 and 0.03 microgram per cubic meter ($\mu g/m^3$), and drinking water levels are generally less than 2 parts per billion (ppb). Absent information on the specific form, a general assumption often made for chromium that has been present in surface soil over time is that 10 to 17% of the total is in the hexavalent form. For groundwater it is often assumed that most is hexavalent. At Hanford, elevated levels of chromium are present in soil (predominantly as the trivalent form) and/or groundwater (predominantly hexavalent) at facilities where sodium dichromate solutions (hexavalent) were used to prevent corrosion in piping.

What Happens to It in the Body? Chromium can be taken into the body by breathing air, drinking water, and eating food. Chromium is not readily absorbed through the skin. When air containing chromium is inhaled, chromium particles can be deposited in the lungs. Particles deposited in the upper part of the lungs are usually coughed up and swallowed. Some of the particles deposited deep in the lungs can dissolve, which allows chromium to pass through the lining of the lungs and enter the bloodstream. Once in the bloodstream, chromium moves to all parts of the body. It then passes through the kidneys and is eliminated in the urine within a few days.

Ingestion of food is the major source of chromium exposure for most people in the United States. On average, adults take in an estimated 60 micrograms of trivalent chromium every day with their food. If taken in as hexavalent chromium, it is rapidly converted to the trivalent form after entering the stomach. When swallowed, most chromium leaves the body within a few days through the feces. A small amount (about 0.4% to 2.1%) will pass through the lining of the intestines and enter the bloodstream. Once in the bloodstream, chromium is distributed to all parts of the body. It then passes through the kidneys and is eliminated in the urine in a few days. Trivalent chromium in food can attach to other compounds that make it easier for chromium to enter the bloodstream from the stomach and intestines. The trivalent form is an essential nutrient in our diet and is used by the body to carry out many important functions.

What Are the Primary Health Effects? The trivalent form of chromium exhibits very low toxicity and is not known to cause cancer. In contrast, hexavalent chromium can be toxic, including causing cancer if it is inhaled. When breathed in, hexavalent chromium can damage the lining of the nose and throat and irritate the lungs as well as the gastrointestinal (GI) tract (stomach and intestines). When swallowed it can upset the stomach and damage the liver and kidneys, and some people have an allergic skin reaction after touching material containing it. Hexavalent chromium is one of a small set of chemicals the Environmental Protection Agency (EPA) has classified as a known human carcinogen, based on studies of workers in chromium processing factories who developed lung cancer after chronic inhalation exposures. However, hexavalent chromium does not cause cancer when ingested, most likely because it is rapidly converted to the trivalent form after entering the stomach.



Primary organs affected when chromium is taken in through food, water, or air.

What Is the Risk? The EPA has developed toxicity values *(see box below)* to estimate the risk of getting cancer or other adverse health effects as a result of inhaling or ingesting chromium. The toxicity value for estimating the risk of getting cancer is called a slope factor (SF), and the value for the non-cancer effect is called a reference dose (RfD). An SF is an estimate of the chance that a person exposed to the chemical will get cancer from taking in one milligram per kilogram of body weight per day (mg/kg-day), for a lifetime. An RfD is an estimate of the highest dose that can be taken in every day without causing an adverse non-cancer effect. These toxicity values have been developed by studying test animals given relatively high doses over their lifetimes, then adjusting and normalizing those results to a mg/kg-day basis for humans, or directly from studies of humans exposed to chromium in the workplace.

Chemical Toxicity Values			
Cancer Risk	**Non-Cancer Effect**		
Inhalation SF *(Cr VI)*	***Oral RfD*** *(Cr III)*	***Oral RfD*** *(Cr VI)*	***Inhalation RfD*** *(Cr VI Particulates)*
42 per mg/kg-day	1.5 mg/kg-day	0.003 mg/kg-day	0.000029 mg/kg-day

To illustrate how the RfD is applied, a 150-lb person could safely ingest 100 mg trivalent chromium or 0.2 mg hexavalent chromium every day without expecting any adverse effects (2.2 lb = 1 kg, or 1,000 g.) In contrast to the RfD, which represents a "safe daily dose" (and so is compared to the amount an individual takes in, as a ratio), the SF is multiplied by the amount taken in to estimate the cancer risk. Using the SF, the EPA estimates that a person would have a chance of one in a million of developing cancer if exposed to air containing 0.00008 $\mu g/m^3$ hexavalent chromium every day for 30 years.

What Are Current Limits for Environmental Releases and Human Exposures? To help track facility releases to the environment, the Superfund amendments that address emergency planning and community right-to-know require releases of certain chemicals to air, water, or land to be reported annually and entered into a nationwide Toxic Release Inventory. For chromium, immediately reportable quantities range from 10 lb (4.54 kg) for chromic acid to 1,000 lb (454 kg) for all other regulated compounds. For drinking water, the EPA has established a maximum contaminant level of 0.1 ppm. The Occupational Safety and Health Administration has established protective levels of 0.5 milligram of water-soluble trivalent chromium compounds per cubic meter of air (mg/m^3) and 1 mg/m^3 for insoluble trivalent chromium compounds; the level for hexavalent chromium compounds is lower at 0.1 mg/m^3.

Where Can I Find More Information? More details can be found in the primary information source for this overview: the Toxicological Profile prepared by the Agency for Toxic Substance and Disease Registry (ATSDR); information is also available through several Internet sources, including ATSDR's ToxFAQS (http://www.atsdr.cdc.gov/toxfaq.html), EPA's Integrated Risk Information System (http://www.epa.gov/iris/subst/index.html), and the National Library of Medicine Hazardous Substances Data Bank (http://toxnet.nlm.nih.gov/cgi-bin/sis/htmlgen?HSDB).